Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

University of Maine

Maine Agricultural Experiment Station

ORONO

BULLETIN 274 DECEMBER, 1918

RESULTS OF PROGRESS ON ANIMAL HUSBANDRY INVESTIGATIONS IN 1917

CONTENTS

	PAGE
Analyses of Milk Records	205
Variations and Mode of Secretion of Milk Solids	210
Cattle Judging as a means of selecting cows for the herd	214
Breeding Experiments	215
Inheritance of Twinning	219
Cooperative Cattle Breeding Records	221

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE

THE STATION COUNCIL

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
THOMAS V. DOHERTY, Houlton,	*Committee of*
FRANK E. GUERNSEY, Dover,	*Board of Trustees*
JOHN A. ROBERTS,	*Commissioner of Agriculture*
EUGENE H. LIBBY, Auburn,	*State Grange*
WILSON W. CONANT, Buckfield,	*State Pomological Society*
FRANK S. ADAMS, Bowdoinham,	*State Dairymen's Association*
LEONARD C. HOLSTON, Cornish,	*Maine Livestock Breeders' Ass'n.*
WILLIAM G. HUNTON, Portland,	*Maine Seed Improvement Ass'n.*

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS, AND THE DEAN OF THE COLLEGE OF AGRICULTURE

THE STATION STAFF

ADMINISTRATION	CHARLES D. WOODS, Sc D.	*Director*
	ESTELLE M. GOGGIN,	*Clerk*
	CHARLES C. INMAN,	*Clerk*
	MARGARET A. PARKER,	*Clerk*
BIOLOGY	FRANK M. SURFACE, PH. D.,	*Biologist**
	JOHN W. GOWEN, PH. D.,	*Assistant*
	RAYMOND PEARL, PH. D.,	*Collaborator*
	MILDRED R. COVELL,	*Clerk*
	HELEN A. RING,	*Laboratory Assistant*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Chemist**
	ELMER R. TOBEY, B. S.,	*Assistant*
	C. HARRY WHITE,	*Assistant*
ENTOMOLOGY	EDITH M. PATCH, PH. D.,	*Entomologist*
	ALICE W. AVERILL,	*Laboratory Assistant*
PLANT PATHOLOGY	WARNER J. MORSE, PH. D.,	*Pathologist*
	DONALD FOLSOM, PH. D.,	*Assitsant*
	VIOLA L. MORRIS,	*Laboratory Assistant*
AROOSTOOK FARM	JACOB ZINN, AGR. D.,	*Assistant Biologist*
	JEREMIAH E. SULLIVAN,	*Superintendent*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
	WALTER E. CURTIS,	*Scientific Aid*
ROYDON L. HAMMOND,		*Seed Analyst and Photographer*

* Absent on leave during period of war.

D. of D.
APR 9 1919

BULLETIN 274

REPORT OF PROGRESS ON ANIMAL HUSBANDRY INVESTIGATION IN 1917.[1]

JOHN W. GOWEN.

In conformity with previous reports,[2] this brief abstract deals with the progress which has been made during the past year in the animal husbandry investigations carried on by the Maine Agricultural Experiment Station. As will be noted the work has been energetically pushed toward the solution of problems already outlined in previous reports and to the gathering of new information for the solution of other problems of importance to us as dairymen. The material advance that has been made in the solution of these problems may best be dealt with by presenting the information under separate headings.

ANALYSES OF MILK RECORDS

The existing records of the milk production of the various breeds as given in the Advanced Registries have further been made use of in the investigations of the past year. The correction factors for the rise of milk and fat production with age have first of all been separately determined for another of the

[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 124.

This report of progress during the year 1917 of the work on animal breeding and related lines (exclusive of the work with poultry) carried on in the Biological Laboratory of the Maine Agricultural Experiment Station, was presented by Director Chas. D. Woods as the report of the Committee on Breeding of the Maine Dairymen's Association, at the meeting held in Portland on Nov. 18, 1918.

[2]Pearl, R., Report of Progress on Animal Husbandry Investigations in 1916, Maine Agri. Expt. Sta., Annual Report pp. 121-144, 1916.

Pearl, R., Report on Animal Husbandry Investigation in 1915, Maine Agri. Expt. Sta. Misc. Publ., 519, 1-27, 1915.

breeds, the Guernsey. As previously pointed out in other reports, a knowledge of these correction factors for a given breed enables a direct comparison of the milk records made at different ages through the use of these factors to correct the records of said animals to their expected maximum. The working out of these correction factors for the Guernsey breed entailed the expenditure of a good deal of time and energy. This work is now completed and the correction factors have been used constructively to determine the influence that certain sires have had on the Guernseys as a breed. For this those sires are chosen which have had 2 or more of their daughters from advanced registry dams, tested. The total number of bulls which have this information is 272. As this report is a record of progress rather than a tabulation of complete results, it seems best that only a limited number of such sires be given and the complete list be reserved for a separate bulletin when a more adequate discussion may be given.

Before pointing out the immense practical bearing of this table on the selection and up-build of the herd, a few limitations of its use as it stands in the present paper, should be discussed. The table takes no cognizance of the absolute milk production of the dams; it only concerns itself with the question of whether the dam's record was higher than that of the daughter's. The importance of recognizing this point is best brought out by an example. It is altogether probable that a bull going into a herd composed of May Rilma's would have a harder time to raise the milk production of his daughters than he would if he went into a herd composed of 4000 pound cows. As a general influence on the herd the bull in the May Rilma herd might be a distinct failure and in the 4000 pound herd a great success. It would very possibly be true that from the breeds point of view it would be wise to transfer the failure of the May Rilma herd to the 4000 pound herd. For the man who had the May Rilma herd it would be wise, in any case, to get rid of the bull failing to maintain the production of his young stock.

Tables 1, 2, and 3 show the effectiveness of 37 Guernsey bulls in raising the production of milk, butter-fat per cent, and butter fat in the milk of their daughters. Each of these bulls

TABLE 1.

Transmitting Qualities for Milk Production of Certain Sires of the Guernsey Breed, as Indicated by the Yearly Records of Their Daughters in Comparison With That of the Dams of These Daughters.

NAME AND REGISTRY NUMBER OF SIRE	LBS. OF MILK BY WHICH THE DAUGHTERS' AVERAGE PRODUCTION IS DIFFERENT FROM DAMS'	
Sires which significantly raised the production of their daughters over that of the dams of these daughters	Is greater than their dams'	Is less than their dams'
Imp. Mashers Galore 8572	2674	
Ne Plus Ultra 15265	2145	
Glenwood's Main Stay 6067	2068	
Imp. Golden Secret of Lilyvale 10028	2028	
Triple Champion 13067	1871	
Glenwood's Stranford 9386	1851	
Imp. King of the May 9001	1847	
Ledyard Bay 11074	1813	
Imp. May Rose King 8336	1664	
Lavanton 11611	1553	
Christie's Combination 14651	1393	
Imp. Cora's Governor of Chilmark 8971	1248	
Lord Waukesha 10148	1114	
Imp. Masher's Sequel 11462	1114	
Jethro Bass 11366	1034	
Starlight's Excelsior 7992	860	
Glenwood's Champion 15639	434	
Glenwood Boy of Haddon 4605	431	
Imp. Spotswood Sequel 9686	393	
Dairymaid's King 12898	304	
Sires which did not significantly raise the production of their daughters over that of the dams of these daughters		
Onoko of Maple Row 11522	126	
Ollie's King of Belle Vernon 8041	120	
Rhea's King of the May 14368	61	
Skeezicks 9979		6
Capt. Robbie 7146		68
Vaillantcoeur 7749		73
Robiana's Standard 7254		78
May King of Ingleside 12558		111
Sires which lowered the production of their daughters as compared with that of the dams of these daughters		
Stranford's Glenwood of Pinehurst 3609		374
Imp. Governor 1 of the Chene 10563		395
Rinaldo 8917		402
Selma's Glenwood 12596		407
Imp. Galaxy's Sequel 16904		835
Casterilius 10980		888
Imp. Galaxy's Lavinius 12548		946
Coralette's Son 3987		984
Malcolm of Maplehurst 5626		1347

TABLE 2.

Transmitting Qualities for Butter-Fat Per Cent of Certain Sires of the Guernsey Breed, as Indicated by the Yearly Records of Their Daughters in Comparison With That of the Dams of These Daughters.

NAME AND REGISTRY NUMBER OF SIRE	PER CENT OF BUTTER-FAT BY WHICH THE DAUGHTERS' AVERAGE IS DIFFERENT FROM DAMS'	
Sires which significantly raised the butter-fat per cent of their daughters over that of the dams of these daughters	Is greater than their dams'	Is less than their dams'
Lord Waukesha 10148	.594	
Ledyard Bay 11074	.398	
Ollie's King of Belle Vernon 8041	.378	
Casterilius 10980	.299	
Onoko of Maple Row 11522	.282	
Imp. Galaxy's Sequel 16904	.244	
Imp. Governor 1 of the Chene 10563	.248	
Imp. Golden Secret of Lilyvale 10028	.188	
Lavanton 11611	.180	
Ne Plus Ultra 15265	.152	
Coralette's Son 3987	.131	
Rhea's King of the May 14368	.128	
Sires which did not significantly raise the butter-fat per cent of their daughters over that of the dams of these daughters		
Triple Champion 13067	.091	
Glenwood's Champion 15639	.050	
Starlight's Excelsior 7992	.025	
Stranford's Glenwood of Pinehurst 13609	.016	
Imp. King of the May 9001	.006	
Capt. Robbie 7146	.003	
Imp. Galaxy's Lavinius 12548		.002
Imp. Cora's Governor of Chilmark 8971		.011
May King of Ingleside 12558		.030
Imp. May Rose King 8336		.049
Robiana's Standard 7254		.080
Malcolm of Maplehurst 5626		.091
Sires which lowered the butter-fat per cent of their daughters compared with that of the dams of these daughters		
Jethro Bass 11366		.112
Imp. Spotswood Sequel 9686		.114
Selma's Glenwood 12596		.130
Christie's Combination 14651		.133
Skeezicks 9979		.141
Imp. Mashers Galore 8572		.196
Glenwood's Stranford 9386		.202
Vaillantcoeur 7749		.231
Dairymaid's King 12898		.244
Glenwood's Main Stay 6067		.251
Rinaldo 8917		.282
Imp. Masher's Sequel 11462		.334
Glenwood Boy of Haddon 4605		.638

TABLE 3.

Transmitting Qualities for Production of Butter-Fat of Certain Sires of the Guernsey Breed as Indicated by the Yearly Records of Their Daughters in Comparison With That of the Dams of These Daughters.

NAME AND REGISTRY NUMBER OF SIRE	BUTTER-FAT PRODUCTION BY WHICH THE DAUGHTERS' AVERAGE IS DIFFERENT FROM THEIR DAMS'	
Sires which significantly raised the butter-fat production of their daughters over that of the dams of these daughters	Is greater than their dams'	Is less than their dams'
Ledyard Bay 11074	138	
Imp. Golden Secret of Lilyvale 10028	124	
Ne Plus Ultra 15265	121	
Lord Waukesha 10148	120	
Imp. Mashers Galore 8572	116	
Triple Champion 13067	107	
Lavanton 11611	103	
Imp. King of the May 9001	93	
Imp. May Rose King 8336	84	
Glenwood's Main Stay 6067	70	
Glenwood's Stranford 9386	68	
Imp. Cora's Governor of Chilmark 8971	66	
Christie's Combination 14651	61	
Starlight's Excelsior 7992	42	
Jethro Bass 11366	39	
Ollie's King of Belle Vernon 8041	38	
Onoko of Maple Row 11522	36	
Imp. Masher's Sequel 11462	20	
Rhea's King of the May 14368	17	
Imp. Governor 1 of the Chene 10563	17	
Sires which did not significantly raise the production of their daughters over that of the dams of these daughters		
Imp. Spotswood Sequel 9686	12	
Capt. Robbie 7146	5	
Glenwood's Champion 15639	5	
Dairymaid's King 12898		9
Casterilius 10980		12
Imp. Galaxy's Sequel 16904		13
Robiana's Standard 7254		13
Stranford's Glenwood of Pinehurst 13609		15
Sires which lowered the production of their daughters as compared with that of the dams of these daughters		
Skeezicks 9979		17
Vaillantcoeur 7749		18
Selma's Glenwood 12596		20
Glenwood Boy of Haddon 4605		39
Imp. Galaxy's Lavinius 12548		47
Coralette's Son 3987		48
Rinaldo 8917		53
May King of Ingleside 12558		70
Malcolm of Maplehurst 5626		78

have at least 7 daughters in the advanced registry which also have the dams of these daughters recorded.

The results of this comparison shows that Imp. Mashers Galore 8572 raised the milk production of his daughters 2674 pounds over that of the milk production of their dams. The same bull lowered the test of the milk of his daughters 0.196 per cent and made a net gain of 116 pounds of butter fat for each of his daughters over that of their dams. This bull quite evidently improved the breed.

The question often comes up, "What bull am I going to buy?" This table enables us to answer the question in so far as the worth of the bull's hereditary qualities to raise or lower the milk production of his daughters over that of the cows to which he is mated, is concerned. An example will make this clear. The bulls Glenwood Boy of Haddon and Imp. Governor I of the Chene are offered for sale, "Which shall I choose to head my herd?" A glance at the table shows us that Glenwood Boy of Haddon caused his daughters to produce 431 pounds of milk over that of their dams; lowered the fat per cent of these daughters on an average 0.638 per cent; and caused a reduction of 39 pounds of butter-fat for the expected year's record. Imp. Governor I of the Chene lowered the production of his daughters 395 pounds of milk; raised the fat per cent of this milk 0.248 per cent; and caused a net increase of 17 pounds of butter-fat. These facts justify us in choosing Glenwood Boy of Haddon to head our herd if milk production is sought. If a high testing milk producing a larger quantity of butter-fat is desired the purchase of Imp. Governor I of the Chene is justified.

VARIATIONS AND MODE OF SECRETION OF MILK SOLIDS

As previously pointed out the study of existing milk records has been actively pushed. These studies on Holstein-Friesian cattle have been gathered together in a paper the contents of which may be briefly summarized. The average annual milk production of these cows was 15417 pounds, containing 528 pounds of butter-fat and 1303 pounds of casein, milk sugar, and ash together with other constituents of less amounts gen-

erally classified as solids-not-fat. The proportion of the butter-fat to the solids-not-fat is 1 to 2.55. This ratio is quite high for cow's milk as found in the other breeds and closely approaches that of human milk.

The interdependence of butter-fat per cent, amount of milk produced and age at commencement of test, in comparison with the association of solids-not-fat per cent, amount of milk produced and age at commencement of test may be determined by the correlation method. The following conclusions were derived from these relations.

As the amount of milk given by the cows in this test increases, the percentage composition of the butter-fat decreases. The amount of this decrease is highly significant measured statistically. Considered practically this fall in butter-fat content could not be easily detected in small samples. No such effect is noted for the solids-not-fat or put in another way, the quantity of milk produced for one year is independent of the concentration of the solids-not-fat. This, from the view of inheritance, means that the hereditary units for high or low milk production are separate and distinct from those causing a high or low percentage of solids-not-fat.

The correlations of the age when the yearly record commences with butter-fat and with solids-not-fat brings out the following points. Age of the cow does not effect the percentage of butter-fat in the milk significantly. As the age of the cow advances each lactation brings with it a decrease in the percentage of the solids-not-fat found in the milk.

This differential action of amount of milk produced and age gives us the citerion to prove that butter-fat and solids-not-fat cannot have a common mother substance from which they are derived by splitting.

The correlations between the variables, pounds of milk, butter-fat and solids-not-fat lead to the following conclusion. (a). Some of the factors responsible for high concentration of butter-fat are also responsible for high concentration of some of the solids-not-fat in cow's milk. (b). Practically considered this means that if it is desired to improve either the butter-fat or solids-not-fat concentration of the milk of a given herd,

the determination of the concentration of either solid and selection of the animals accordingly will result in a corresponding increase for the other solid.

Taken in conjunction with the above results the diurnal variations of cow's milk furnish the facts necessary to test the hypothesis to account for the mode of secretion of the milk solids. The data show that evening milk is between 0.678 and 0.723 per cent higher in butter-fat than the morning milk throughout the whole lactation. No appreciable difference occurs in the solids-not-fat.

For the clear understanding of the bearing of these data on the hypothesis to account for the mechanical mechanism by which the solids are released into the milk, it seems best to restate them in as simple terms as possible. These hypothesis may be placed in 3 groups:

A. The mammary gland cells break loose bodily and disintegrate in the alveoli.

B. The portion of the cells toward the alveoli become loaded with solids, break loose from the basal portion and disintegrate to form the milk solids.

C. The cells of the mammary gland secrete the materials of milk solids without themselves breaking down.

These data offer citeria between the theories to account for the secretion of the milk solids. On the cell disintegration theories the cell must contain a fixed quantity of solids-not-fat while the butter-fat varies so that in the longer interval between milkings the cell accumulates less fat than in the shorter time, or taken the other way, the cell contains relatively more protein and sugar than fat as the interval between milkings lengthens. This is contrary to our knowledge of fat formation for it is commonly accepted that first comes the cells composed largely of protoplasm and that as time goes on this cell is more and more loaded with fat at the expense of the protoplasm. Unless these mammary cells behave very differently in the formation of this fat than other body cells this variation is enough to seriously discredit the hypothesis of cell disintegration to account for these milk solids and in fact, to make it an absurdity. Furthermore, as far as our knowledge of the variations of secretory

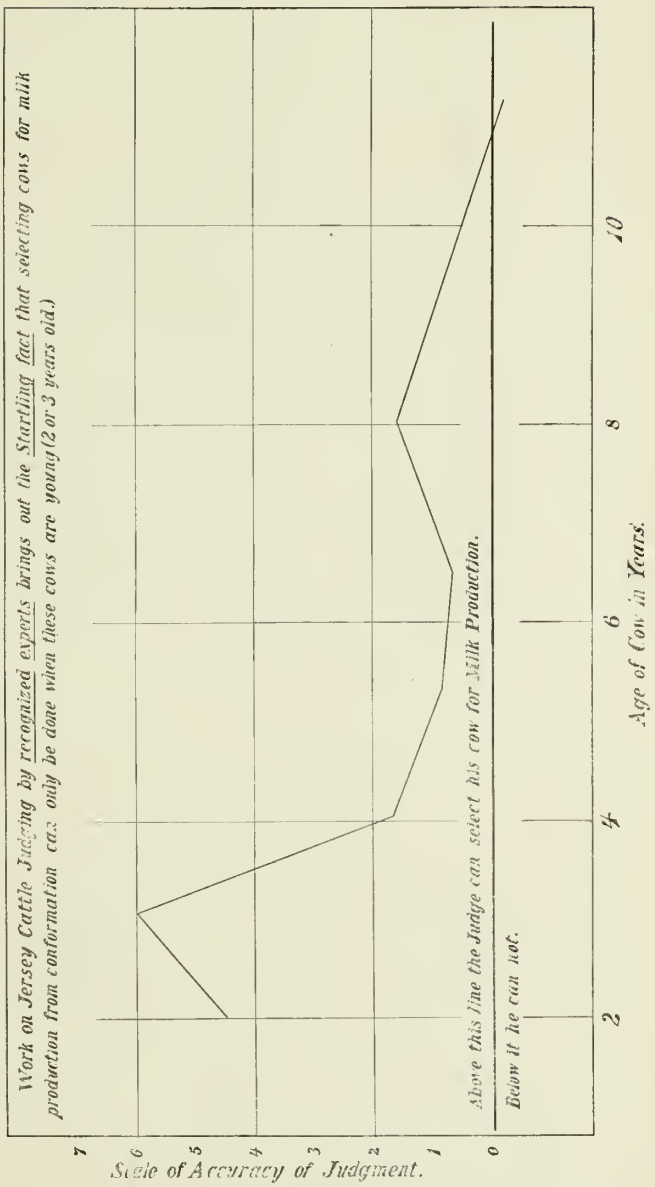

Work on Jersey Cattle Judging by recognized experts brings out the Startling fact that selecting cows for milk production from conformation can only be done when these cows are young (2 or 3 years old.)
Above this line the Judge can select his cow for Milk Production.
Below it he can not.
Scale of Accuracy of Judgment.
0
1
2
3
4
5
6
7
2
4
6
8
10
Age of Cow in Years.

FIGURE I. Relation between Milk Production and their Adjudged Score of Jersey Registry of Merit Cows for Successive Age Groups.

Greatest accuracy of selection for milk production according to conformation is at 3½ years.[3]

glands goes the variations of this milk, fall in well with the secretory hypothesis to account for these solids.

CATTLE JUDGING AS A MEANS OF SELECTING COWS FOR THE HERD

The importance of this question would be hard to overestimate as a knowledge of the kind of conformation that goes with a high milk producing cow would be of material aid in the buying of cows for the herd and also for the selection of young heifers to be kept for further use. As indicated by a previous report the Biological Laboratory has a project on foot to accumulate an exact body of data to determine the relative value of the points used in judging dairy cattle for milk production. This work is progressing favorably. In the meantime use has been made of data found in volume 1 of the Registry of Merit published by the American Jersey Cattle Club. These data give the milk, butter-fat and butter-fat per cent together with the scores of some 672 milk cows at different ages. The resulting correlation of milk production and scores for the different age groups are shown in Table 4.

TABLE 4.

Correlation between Milk Production and Score of Jersey Registry of Merit Cows for the Successive Age Groups.

Age at Commencement of Test	Number of Animals	Correlation and Probable Error
1 year 6 months–2 years 6 months	190	—0.2117±.0467
2 years 6 months–3 years 6 months	144	—0.3088±.0508
3 years 6 months–4 years 6 months	98	—0.1080±.0673
4 years 6 months–6 years 0 months	94	—0.0608±.0693
6 years 0 months–7 years 0 months	37	—0.0752±.1103
7 years 0 months–9 years 0 months	70	—0.1863±.0778
9 years 0 months–and above	39	+0.0345±.1079

The data of this table show clearly that the cattle judge can only select the high producing cow from her external con-

[3]It should be remembered that the individual scores are those of Registry of Merit Cows which have year records of milk, butter-fat and butter-fat percent. The scores are all by judges of recognized merit. The scale of accuracy of judgment is taken as the correlation divided by its probable error.

formation when she is about 2 to 3 years old. Since these men who did the judging are recognized as experts it emphasizes even more strongly than it appears that the dairyman buying cattle for his herd should choose young stock as then he is more likely to choose the high producing cow at such time.

Figure 1, page 213, is inserted to show diagramatically this relation of milk production and score at the different age groups for Jersey Cattle, taking cognizance of their probable error.

These studies are now being continued on a larger scale by the help of the American Jersey Cattle Club in rendering any assistance they are able in furthering these studies. Through their kindness they have allowed us to copy the complete score cards on a much larger series of animals. The analyses of these records are being pushed and in due time are expected to give significant, practical results.

BREEDING EXPERIMENTS

The experiments in cattle breeding which are being carried out in cooperation with the University of Maine have progressed more slowly than in previous years. As pointed out in past reports these experiments are definite cross-breeding experiments so planned as to furnish data on problems of inheritance of milk, butter-fat and butter-fat per cent. All are familiar with the fact that such experiments are absolutely necessary for the adequate analyses of the laws of heredity behind the transmission of these qualities.

The most important results will come of course in the second hybrid generation. To October 16, 1918, 8 of these animals have been produced which will be retained in the herd. Of the first generation hybrid 25 are to be permanently kept in the herd for the production of the second generation. To make the herd of first generation animals complete only 2 more animals are necessary.

The herd has now reached the stage where first results are being obtained. Of the first generation heifers 8 are in milk, some of them for the second lactation; of the second generation one heifer is in milk. The results from this heifer are of especial interest for the reasons indicated above.

TABLE 5.

Calves Which have been Produced in the Hybridization Experiments between February 9, 1917 and October 15, 1918.

Calf	Sex	Dropped	Sire's Name and Registry Number	Breed of Sire	Dam's Name and Registry Number	Breed of Dam
42	♀	March 25, 1917	Crossbred No. 0	Jersey x Holstein-Friesian	Flora's Golden Poetess (264927)	Jersey
43	♂	April 30, 1917	Crossbred No. 0	Jersey x Holstein-Friesian	Crossbred No. 1	Jersey x Holstein-Friesian
44	♀	May 4, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Orono Madge (192781)	Aberdeen-Angus
45	♀	May 13, 1917	Kayan (167617)	Aberdeen-Angus	Pauline Posch (81048)	Holstein-Friesian
46	♀	June 6, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Lassie of M. F. (297736)	Jersey
47	♀	August 6, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Hearthbloom (147141)	Aberdeen-Angus
48	♂	August 10, 1917	Crossbred No. 0	Jersey x Holstein-Friesian	Crossbred No. 11	Jersey x Holstein-Friesian
49	♀	August 15, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Crossbred No. 2	Holstein-Friesian-Guernsey
50	♂	August 22, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Eventime 4th (155526)	Aberdeen-Angus
51	♂	August 27, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Crossbred No. 12	Holstein-Friesian-Guernsey
52	♂	October 11, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Orono Ellen (192783)	Aberdeen-Angus
53	♂	October 21, 1917	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Rosalie (M. S. J. C. A. 4887)	Jersey
55	♀	January 14, 1918	Crossbred No. 17	Aberdeen-Angus x Jersey	Crossbred No. 15	Jersey x Aberdeen-Angus
56	♂	January 19, 1918	Crossbred No. 17	Aberdeen-Angus x Jersey	Crossbred No. 16	Aberdeen-Angus x Jersey
57	♀	March 3, 1918	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Orono Madge (192781)	Aberdeen-Angus
58	♀	March 21, 1918	Kayan (167617)	Aberdeen-Angus	Rue Victoria (273096)	Jersey
59	♀	April 7, 1918	Crossbred No. 14	Holstein-Friesian x Jersey	Crossbred No. 1	Jersey x Holstein-Friesian
60	♀	May 25, 1918	Kayan (167617)	Aberdeen-Angus	Crossbred No. 22	Aberdeen-Angus x Guernsey
61	♀	June 21, 1918	Lakeland's Poet (102603)	Jersey	Delva Johanna DeKol (146774)	Holstein-Friesian
62	♀	June 28, 1918	Kayan (167617)	Aberdeen-Angus	Pauline Posch (81048)	Holstein-Friesian
63	♀	July 24, 1918	Lakeland's Poet (102603)	Jersey	Crossbred No. 11	Jersey x Holstein-Friesian
64	♀	July 31, 1918	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Lassie of M. F. (297736)	Jersey
65	♂	August 21, 1918	Crossbred No. 32	Aberdeen-Angus x Guernsey	Creusa of Orono 2nd Primrose (75232)	Guernsey
66	♀	August 24, 1918	Lakeland's Poet (102603)	Jersey	Crossbred No. 25	Jersey x Holstein-Friesian x Jersey x Holstein-Friesian
67	♂	September 17, 1918	Crossbred No. 32	Aberdeen-Angus x Guernsey	Crossbred No. 26	Aberdeen-Angus x Guernsey
68	♀	Setpember 21, 1918	Nepaul (23330)	Guernsey	Crossbred No. 12	Hostein-Friesian x Guernsey

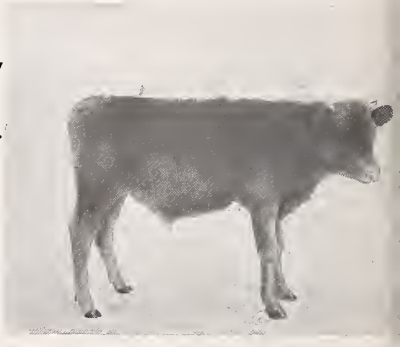
Lakelands Poet - Bull

P.

Color - Dark Fawn

Crossbred No. 0 - Bull

F_1



Black and White

Delva Johanna De Kol - Cow

P.

Black and White

The Photographs in this plate are adapted from the results of our Crossbred Herd to show what a backcross is and what the proportions of the two kinds of offspring would be expected from such a type of mating. Lakeland's Poet is pure bred Jersey bull, pure for the Fawn coat. Delva Johanna DeKol is a pure bred Holstein-Friesian cow, pure for the Black coat. The result of mating these two animals together was the bull Crossbred No. 0. Crossbred No. 0, of the first *Filial* generation after the cross (F_1), has one inherited dose of Fawn and one inherited dose of Black. That is one-half of Crossbred No. 0 material for coat color comes from his sire and one-half from his dam. Such an animal which has only one hereditary unit for Black as against the pure animal having two is said to be heterozygous for Black. Crossbred No. 0's coat is Black, which in technical language means that Black is dominant to Fawn. Similarily Fawn is said to be recessive to Black. Crossbred No. 0 is mated back to pure fawn cows. This type of mating is called a back cross for black coat color, as the mating is of a bull

Rosalie - Cow

Crossbred No. 63 - Cow

F_2

Fawn

Black

Flora's Golden Poetess - Cow

Crossbred No. 42 - Cow

F_2

Fawn

Fawn

with one dose of Black and one dose of Fawn mated back to a cow pure for the recessive Fawn. The results expected on the one dose hypothesis of hereditary material for Black are illustrated in the photographs. That is, there will be one Fawn animal to one Black animal. Two kinds of mating, both backcrosses, will give this result. The first is illustrated above the second is that of a cow heterozygous for Black mated to a Fawn bull. The expected results are the same for the black body color, and the backcrosses are called reciprocals of each other. In actual point of fact Crossbred No. 63 was produced by this reciprocal mating. For illustrative purposes, however, it was thought best to show the results without this additional complication.

The complete figures to date for a heterozygous bull mated to pure fawn cows are one black to four fawn. For the reciprocal cross of pure bred bull on heterozygous cows are one black to one fawn. Photographs colored by Mrs. W. J. Morse.

The complete list of the calves which have been born into the cross-bred herd from February 7, 1917 to October 15, 1918 is shown in Table 5, page 216. This list together with those of previous reports will give the cross-bred animals thus far obtained.

The herd has already furnished the data for a bulletin[4] which is now in press. The results with which the bulletin dealt are, of course, largely those of color inheritance. The importance of such results is evident as it is already well known that the inter-relationship between inheritable characters is such that a knowledge of the inheritance of the colors of the cattle coat may lead to a knowledge of the inheritance of the factors for milk production. It is necessary, of course, to know the hereditary behavior of the coat colors, etc., before advantage can be taken of this knowledge. This first bulletin was planned to deal only with this color inheritance. In later studies the association of these characters with milk and butter-fat production will be considered.

The essential results may be quoted from the summary as follows:

"No influence on the vigor of the offspring would be expected from the width of the out-crosses as inbreeding studies showed the inbreeding low in amount.

"Black body color is dominant to the other colors in the first generation. In the second generation there occurred an orange coated bull and a dark Jersey heifer. This is to be expected on the grounds of a recessive dilution factor in the Guernsey breed. This factor is not normally present in the Jersey breed.

To clearly show the inheritance of Black and Fawn, Plate I has been drawn up to illustrate how the actual crosses were made and the coat colors of the resulting offspring.

"It has been shown that white marking of the body taken as a whole appears as a dominant. Study of the individual white areas, however, indicate that this is due to white in the

[4]Gowen, John W. Inheritance Studies of Certain Color and Horn Characters in First Generation Crosses of Dairy and Beef Breeds. Bulletin 272, Maine Agricultural Experiment Station.

inguinal region only for this alone appears as such a dominant. The white spots on the face (star, star snip and blaze) neck, shoulders, rump, flanks and legs are, in general, suppressed in the offspring when animals with these markings are mated to solid colored animals.

"As has been suggested but as has never been tested before the pigmented muzzle is dominant to the unpigmented muzzle.

"A black switch appears to cause the suppression of the other switch colors in the offspring. Because of this suppression and because all of the matings had at least one animal with a black switch as parent, it was impossible to study the behavior of the other colors. There was one case of segregation of a deep red orange switch from a back cross of a black animal carrying an orange coat and white switch, genetically. This case showed the separation of the factor for this red from that for both white and black.

"The character of polledness has been studied. Two horned animals resulting from crosses of polled x horned appeared. On the basis of the other results these could not have resulted from a heterozygous polled condition. One of these cases had the horns tight on the head and the other loose. These cases then form exceptions to the previously accepted hypotheses of simple dominence for the polled character and require a subsidary hypothesis. The hypothesis suggested is that the male sex organs have some action on the presence or absence of horns. Partial proof of this hypothesis is given by the fact that of the polled animals 10 were females, 2 males, 1 of which was doubtfully polled. Of those with scurs 1 female and 7 males had loose scurs; of those with tight scurs all (3) were males; of those with horns, all (2) were males. This would seem like a clear case where the male has some influence. The explanation of this difference appears to be due to a substance secreted by the germ cells. Should this prove true this forms an interesting parallel between cattle and sheep where the sex glands are known to produce such changes.

"The inherited characters of the beef type are shown to be divisible into 4 general regions of the body, head, fore quarters, barrel and hind quarters. The type of head and heavy, deep

fleshed fore quarters are transmitted to the offspring when either parent is of the Aberdeen-Angus breed. The body and hind quarters appear intermediate but in most cases resemble the dairy parents.

"Data are given on the milk and fat production of some 4 of the cross-breds. The results indicate that milk and fat production are inherited separately. High milk production is dominant to low, high fat per cent is recessive to a low fat per cent in the milk. Put in less technical language the results of this cross indicate that in a cross between an animal from a high milking strain mated to one of a low milking strain, the resulting female offspring will have the milk production of the high strain. In a cross between animals one of which is from a high test line and the other from a low test line the resulting offspring will have a butter-fat test of the low test line. The number of these milking first generation females is not great enough to make this statement an absolutely sure conclusion."

Inheritance of Twinning and Problems Connected Therewith

During the past year a new project to obtain information of the frequency of twinning in cattle has been set in operation. In all some 500 of progressive breeders of the United States have responded with some very excellent data on this subject. It is, of course, too early to have analyzed the results obtained from this investigation. Some idea of the scope of the information may be had by a glance at the reproduction of the form used as shown below.

Maine Agricultural Experiment Station

Chas. D. Woods, Director

This Information Will Be Held Strictly Confidential

SPECIAL REPORT—MULTIPLE BIRTH RECORD

Name..... Address.....
On.....there was born at your farm a set of
.....Twins.....from the dam.....and sired by
.....More complete information about this

multiple birth is desired. I shall be greatly obliged if you aid the solution of this important problem by filling out this blank to the best of your knowledge.

BREEDING HISTORY OF DAM

Were these.....TWINS.....her first calves?.....
If not, what has been her previous breeding history?.....
(The following tabular arrangement may be used in answering.)

Pregnancy	Year	No. of Young	Sex of Young	Sire of Calf or Calves

Did any of the two grand-dams, or four great grand-dams ever have more than one calf at birth?.....
If so please name them.....
Do you know of any tendency to multiple births in any of the relatives of either the sire or dam of these calves?.....*(Give as many particulars as you can)*.....
Has the sire of these TWINS ever sired any other twins or triplets?.....If so give Names and Dates.....
TWIN DESCRIPTIONS. *(If these be triplets name unrecorded animal)*.....
Are either or both animals sterile?.....Name which.....
Do the females come in Heat?.....Will they take the bull?.....
If not, do they show any tendency to cover cows?.....Cite cases.....
If a freemartin or sterile, describe the external appearance of the crest, udder and genital organs.....
What is your breeding practice with freemartins?.....
Do you register a freemartin before it has bred?.....Have you had any other multiple births in your experience?.....If so, please describe them.....

Name of Twins	Dam	Sire

For the sake of helping to get definite information on cattle twins, would you be willing to let me know should other twins occur and fill out a similar blank?.....

Give any other information you can on the back of sheet.

In the above connection the cross-bred herd has furnished a heifer twin to a bull which is of great interest both practically and theoretically. This animal Cross-bred No. 19 came in heat

when 1 year and 236 days old. She was served one-half hour after the appearance of this heat by a vigorous young bull in the cattle yard. At this service she stood for 3 coverings of her own free will manifesting no difference in behavior from other normal cows. Subsequent anatomical examination showed this animal to be a typical freemartin with no uterus or ovary. The place of the ovary was taken by what is called the saccus vaginales with what appear to be the homologue of the gonad inside. This perverted gonad is about the size of a small pea bean.

From these facts the following conclusions appear justified. (1) A typical freemartin can come in heat that to all appearances is normal. (2) Heat can appear in cattle where only gonads of very different appearance from that of either normal sex is present. (3) The deduction appears justified that the growth or release of the egg is not the cause for the appearance of heat.

Cooperative Cattle Breeding Records

The cooperative cattle breeding project, in which about 200 of the leading breeders of cattle in Maine, and a few outside the State, have contributed was closed in September 1917 as the mass of the material collected was sufficient to satisfy the objects of its collection. As previously pointed out in other reports the amount of these data are very large, constituting a wholly unique mass of material for the study of many of the most vital problems in the physiology of reproduction in cattle.

These large amount of data will take a considerable time to analyze completely. Already some facts of considerable practical and scientific interest are available which it seems well to place immediately in the hands of the dairymen of the State. The points that will be dealt with are 5, (a), the effect of the size of the breed on the weight of the calf; (b), the normal length and variation of the period of gestation; (c), the change in the sex ratio due to twin births; (d), the time after the appearance of heat that service is most likely to cause conception to take place; (e), the decline in the number of conceptions as the number of necessary services increases.

(a) THE EFFECT OF THE SIZE OF THE BREED ON THE WEIGHT OF THE CALF

The fact that animals of a given breed vary in their weight at birth is something which has been known ever since animals were born. The difference in the weights of the births of one breed as directly compared with the weights of another breed is not so well known. Table 6 furnishes the material to make such a comparison extracted from the records collected by the Maine Agricultural Experiment Station through the active co-operation of the stock breeders of the State.

TABLE 6.

Table Showing the Average Birth Weights of Certain of the Breeds of Dairy and Beef Cattle.

Breed	Average birth weight in pounds
Grade Jersey	60.1114± .5887
Pure bred Jersey	53.9384± .5907
Grade Guernsey	67.9250± .8220
Pure bred Guernsey	63.4000±1.2469
Grade Ayrshire	61.1667± .8275
Pure bred Ayrshire	69.5918± .7797
Grade Holstein	80.8082± .5255
Pure bred Holstein	92.8761± .8791
Grade Shorthorn	65.7692±1.8316
Dutch belted	64.4737±1.1746
Grade Brown Swiss	75.0000±2.1198
Grade Aberdeen-Angus	74.0909±2.3681

The following facts come from a study of the cooperative records. The smallest breed also has the smallest weight at birth. The grades of the island breeds are generally larger than the pure breds. This is due probably to the influence of the blood from larger breeds found in the pedigree of the island grade stock. Pure bred Holstein-Friesian calves have the largest weight at birth showing that because an animal is bred to produce milk is no guarantee that its size at birth will not be as great as that of one of the properly beef breeds.

(b) THE NORMAL LENGTH AND VARIATION OF THE PERIOD OF GESTATION IN CATTLE

The analyses of the records on the average length of gestation in dairy cattle furnish striking evidence of the accuracy of certain human opinions grown up through years of experience. In 1197 records of cattle births where the length of gestation was known, the average duration of gestation was 281 days, 15 hours and 45 minutes, or nearly the customary reckoning of 282 days. Half of these births had a length of gestation between 277 days and 286 days. The full range of the length of gestation for the births was from 215 days to 315 days or a range of 100 days. Since there were no abortions included in the data it seems that under normal conditions the length of gestation may have considerable range even though most of the births are concentrated around one point.

(c) THE CHANGE IN THE SEX RATIO DUE TO TWIN BIRTHS

The sex ratio which exists in twins has always been of considerable interest both from the point of view of mode of twin production and the manner in which identical twins are produced. Our cooperative records furnish us some data on this question which are of great interest. In 2573 births there were produced 21 twins or the proportion of twin births is about 1 in every 125 births or 8.17 in 1000, compared to a frequency of twinning among women[6] of about 1 in 89. The conclusion follows that the frequency of twinning varies considerably with the species even in those which normally produce only one offspring at birth.

Of especial interest is a comparison of the sex ratio as it occurs in human and cattle births. In the 21 births above mentioned 3 were 2 males, 14 were male and female and 4 were 2 females. Combining this data with that of Lillie,[7] as they are

[6]Veit, "Beitrage zur geburtshulflichen statistik, "Monatsschr f. Geb. vol. VI., 1855.

[7]Lillie, F. R., The Freemartin; a Study of the Action of Sex Hormones in the Foetal Life of Cattle. Jour. of Expt. Zoo. Vol. 23, No. 2. pp. 371-452.

entirely comparable being random samples of cattle twins we have 22 where both are males, 38 where there are twins of each sex, and 15 where both are females, or there are 37 twins of the same sex to 38 of opposite sex, a condition as close to the 1:2:1 chance radio as could be well hoped for. Comparing this with data presented by Nichols[8] where he found 234,497 where there were 2 males, 264, 098 where the twins were of opposite sex, and 219,312 where the twins were both females or as against the 1 like to 1 opposite sex of twins in cattle, the human family, have 1.7 like to 1 opposite sex. The excess of the like sexed twins in the human family is known to be due to the identical twins, where two individuals of like sex come from one egg.

The figures given above show that cattle do not produce this excess over the 1 like sex to 1 opposite sex. Since this is true, it appears that in cattle the embroyological mechanism is such that it does not favor the production of identical twins. This conclusion is further borne out by evidence collected during the past year on the resemblance of the members of a pair of like sexed twins.

(d) THE TIME AFTER THE APPEARANCE OF HEAT THAT SERVICE IS MOST LIKELY TO CAUSE CONCEPTION TO TAKE PLACE

Knowledge of problem (d) and (e) is so closely associated to successful cattle raising as to be almost essential to the proper management of the herd. The analysis of large series of data on these problems collected through the cooperative efforts of the Maine Station and the Maine Cattle Breeders is therefore especially instructive. Table 7 presents the necessary data for the first of these problems.

TABLE 7.

The Duration in Hours of the Time Between Appearance of Heat and Service Together with the Sex of the Resulting Offspring.

Sex of Offspring	Hours lapsed between time when heat was noticed and time of service																																						Total
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	35	41	52	69	
Male	77	132	116	154	77	81	44	59	33	41	24	35	20	31	21	16	10	8	2	7	1	5	4	4	9	1		1	3	1									1017
Female	77	131	90	147	66	85	40	60	45	38	26	31	34	26	19	20	9	9	1	3	3	10	3	2	6	2	1	1			1			1		1			988
Twins																																							
Two Males	1	1			1																																		3
Male and Female	2	2	2	2			1	1				1						1																						12
Two Females						1					1			1																										3
Sex unknown	2	8	5	6	5	2	1	3	2	3		1		2			1	1																						42
Total	159	274	213	309	149	169	86	123	80	82	51	68	54	60	40	36	20	19	3	10	4	15	7	6	15	3	1	2	3	1	1			1		1			2065
Unsuccessful Service	38	104	70	114	39	60	26	37	20	40	20	17	12	15	8	11	4	4	1	3	2	2	2	1	2	1		2	1			1	1		1		1	1	661
Total	197	378	283	423	188	229	112	160	100	122	71	85	66	75	48	47	24	23	4	13	6	17	9	7	17	4	1	4	4	1	1	1	1	1	1	1	1	1	2726

The necessary reduction of the statistics of table 7 to their means and constants to measure their variability is seen in table 8.

TABLE 8.

Means, Standard Deviations and Coefficients of Variation for the Hours between Observed Appearance of Heat and Service of the Cow.

Sex of Offspring	Discovery of Heat to Service	Standard Deviation	Coefficient of Variation
Male	5.9550± .1129	5.3355±.0798	89.5967± 2.1654
Female	6.1417± .1165	5.4285±.0824	88.3882± 2.1467
Two males	1.9167± .6619	1.6997±.4680	88.6786±39.1673
Male and female	4.6667± .9554	4.9068±.6756	105.1450±25.9416
Two females	9.5833±1.2850	3.2998±.9086	34.4330±10.5529
Sex unknown	5.1548± .4426	4.2528±.3130	82.5020± 9.3316
Total successful services	6.0200± .0795	5.3596±.0563	89.0302± 1.5032
Unsuccessful services	5.8627± .1574	6.0009±.1113	102.3565± 3.3417

The above data indicates the following conclusions.

(1) Successful services may occur 41 hours after the first observance of heat.

(2) The duration of the observed period of heat before service in the unsuccessful services extends up to 69 hours. The interval hours covered in these unsuccessful services is therefore slightly longer than in the successful ones.

(3) The average number of hours between observance of heat and services is the same (within the errors of random sampling) for the successful and unsuccessful services.

(4) When analyzed in groups of five hours periods it is found that the unsuccessful services occur most frequently in the 0-5 and 25 and above hour periods as compared with the successful services. From this the conclusion seems justified that the best time for service would be between 5 and 10 hours after appearance of heat.

(5) The choice of this time for service would not cause any difference in the sex of the resulting calves for Table 8 shows the average number of hours from the time heat is observed to service is the same whether the resulting birth be male or female.[8]

[8]Loc. Cit.

This conclusion in itself is important as one of the primary objects for which the cooperative record project was inaugurated was to collect statistics bearing on the question as to whether the proportion of males to females in cattle could be influenced or controlled by the time of service relative to the beginning of the period of heat. Some earlier statistics[9] appeared to indicate that there was a possibility of influencing the sex ratio by paying attention to this point.

The statistics analyzed in Table 8 probably prove conclusively, that the apparent relation between these two factors, which is believed by many breeders to exist and which our earlier studies appeared to indicate, was purely accidental. In fact taken on its face value without regard to probable errors instead of their being more females resulting from services in early heat, there are actual a slight access of males.

The conclusion of the previous incomplete analysis[10] of the cooperative data is therefore substantiated, that there is no significant preponderance of females when the service is early in heat.

(e) THE DECLINE IN THE NUMBER OF CONCEPTIONS AS THE NUMBER OF NECESSARY SERVICES INCREASES

This problem is an ever occurring one in the breeding operations of any dairy herd. When shall a valuable animal be sold as a non-breeder? This, of course, depends on the number of service trials the cow has had. Data on the time when conception took place in a large series of connected birth and service records are valuable in our cooperative records. These data are shown in Table 9.

[9]Pearl, R., and Parshley, H. M. Sex Studies V—Data on Sex Determination in Cattle. Biol. Bulletin, vol. 24, pp. 205-225, 1913.

Pearl, R. Brief Report of Progress on Animal Husbandry Investigations in 1914, Me. Agric. Expt. Sta. Misc. Publ. 503, pp. 1-11, 1914.

[10]Loc. Cit.

TABLE 9.

Table Showing the Number of the Services at which Conception Took Place in 1801 Births of Dairy and Beef Cattle.

Ordinal No. of services given at which conception took place	No. of cows conceiving at this particular service in the series of services	Percentage of cows conceiving at this service in the series of services
1	1412	78.40
2	277	15.38
3	82	4.55
4	18	1.00
5	7	.39
6	2	.11
7	1	.06
8	1	.06
9	0	.00
10	1	.06

This table shows that of 100 cows which are bred 78 of them conceive (so called stick) at the first service; 15 of them conceive at the second service; 4 at the third service; 1 at the fourth service and from this the number that conceive becomes so small as to be almost negligible. The place in this series at which the dairyman is justified in selling his cow is, of course, a matter for him to decide. It seems doubtful, however, if it would pay to keep a cow beyond the fifth service unless she is of considerable value.

[8]Loc. Cit.